

**TAXONOMIC REVIEW OF *CALLIOPSIS* SUBGENUS
HYPOMACROTERA (HYMENOPTERA: ANDRENIDAE),
WITH SPECIAL EMPHASIS ON THE DISTRIBUTIONS
AND HOST PLANT ASSOCIATIONS**

BRYAN N. DANFORTH

Department of Entomology, Comstock Hall, Cornell University,
Ithaca, New York 14853

Abstract.—Two names, previously used to designate subspecies of *Calliopsis* (*Hypomacrotera*) *callops*, are herein used to refer to distinct species: *C. (H.) callops* (Cockerell & Porter) and *C. (H.) persimilis* (Cockerell). These two species are described and the data on floral host association and distributions are listed and illustrated. These two species, plus *Calliopsis* (*Hypomacrotera*) *subalpinus* Cockerell, comprise the monophyletic subgenus *Hypomacrotera*. Floral association and distribution data from over 850 specimens are analyzed. *Calliopsis callops* and *C. persimilis* are oligolectic on a group of closely related genera in the family Solanaceae; the former on *Chamaesaracha* and *Quincula* and the latter on *Physalis*. *Calliopsis subalpinus* is clearly oligolectic on mallows in the genus *Sphaeralcea*. *Calliopsis persimilis* and *C. callops* are parapatric with a narrow region of overlap in the San Simón Valley, near the Continental Divide in southern Arizona. *Calliopsis subalpinus* ranges widely across the southwestern deserts from southern California to southwestern Texas and southward to northern Mexico.

Key Words.—Insecta, Apoidea, taxonomy, floral associations

This paper establishes that the previously recognized subspecies of *Calliopsis* (*Hypomacrotera*) *callops* (Cockerell & Porter) are, in fact, two easily distinguishable species. Rozen (1970) anticipated these taxonomic changes in a study on the nesting biology of *C. callops*. In addition to this minor taxonomic point, an account of the distributions and floral associations of the three valid species in the subgenus *Hypomacrotera* is given.

Quantitative investigations into floral specialization are rare (except see Heithaus [1979]), in part because in many groups of oligolectic, or pollen specialist, bees there are not enough specimens with associated floral data collected over large areas to provide sufficient data for such an analysis. Because the species within *Hypomacrotera* have been collected in the southwestern United States and northern Mexico during the last century by many different collectors, large numbers of specimens with associated floral data are available in museum collections. As a result, *Hypomacrotera* makes an excellent case study in bee floral specialization.

Hypomacrotera was first named by Cockerell & Porter (1899) to include *H. callops* (the type species) and *H. subalpinus* (previously placed in *Calliopsis*). For the purposes of this study, I accept the view that *Hypomacrotera* is a monophyletic group, as indicated by Ruz (1991). The monophyly of *Hypomacrotera* was supported by her characters 52 (propodeal triangle smooth) and reversal to the plesiomorphic state in character 71 (tarsomeres 2–4 of male hind leg expanded; they are not expanded in *Hypomacrotera*). The presence of darkened areas at the apices of the forewings in males (and females in two of the three species) is another common character, but one not unique to *Hypomacrotera* within *Calliopsis* (Ruz 1991: 232).

In the taxonomic descriptions given below, I have used the surface sculpturing terms explained in Harris (1979). Morphological terms follow Michener (1944) except the sternum and tergum of the first metasomal segment (homologous to the second abdominal segment) are called tergum 1 (abbreviated T1) and sternum 1 (abbreviated S1), respectively. The following metasomal sclerites are numbered sequentially thereafter. Measurements are expressed as mean \pm standard error of the mean.

Depository Abbreviations.—The locations of specimens used in this study are indicated with the following abbreviations: American Museum of Natural History (AMNH), Snow Entomological Museum, University of Kansas (KU), Los Angeles County Museum of Natural History (LACM), University of California, Riverside (UCR), California Academy of Sciences (CAS), National Museum of Natural History, Smithsonian Institution (NMNH), Central Texas Melittological Institute (CTMI), and Universidad Nacional Autonoma de México (UNAM). In Material Examined the locality data are listed hierarchically, and the numbers of females and males are indicated in brackets as follows: [number females, number males].

CALLIOPSIS (HYPOMACROTERA) PERSIMILIS (COCKERELL)

Hypomacrotera callops persimilis Cockerell (1899:8) [male, female]; *Calliopsis (Hypomacrotera) persimilis*, Danforth (1990) [biology].

Types.—Cotypes, male; data: ARIZONA. *MARICOPA Co.*: Phoenix, 7 Oct [no year], *Tribulus grandiflora*, 1 male; deposited: California Academy of Sciences, San Francisco. Cotypes, females; data: same as male except collected 9 Oct on flowers of *Physalis*, unknown number; deposited: unknown.

Although the male of the cotype series is clearly the basis for Cockerell's account of this species, to the best of my knowledge he did not formally designate a holotype and I here designate this male the lectotype.

Description.—*Female.*—Head: (1) width 1.88–2.00 mm (\bar{x} = 1.91 \pm 0.02; n = 10); (2) 1.35–1.48 (\bar{x} = 1.41 \pm 0.01; n = 10) \times broader than long, as measured from vertex to lower margin of clypeus; (3) clypeus distinctly punctate with weak imbrication; (4) frons mostly shiny with scattered punctations, more imbricate above antennal sockets; (5) vertex shiny and nearly impunctate; (6) gena shiny and nearly impunctate; (7) head coloration dark brown to black, no maculation; (8) head lightly clothed in erect white setae, most dense and longest setae on gena, posterior surface of head and vertex; (9) inner margins of eyes diverging slightly below; eyes brown; (10) lateral ocelli separated from median ocellus by 1 ocellar diameter; (11) facial foveae weakly impressed, concave surface slightly dull; (12) scape equal in length to flagellar segments 1–6; flagellum lighter brown ventrally and apically. Mouthparts: (13) labrum with proximal impunctate concave area separated from distal punctate area by ridge; (14) mandible dark brown basally becoming light brown apically; simple; (15) glossa short, two-thirds length of prementum; (16) paraglossae broad and blade-like; (17) labial palpus 4-segmented with segments 2–4 equal in length to segment 1; (18) galeal comb present; (19) maxillary palpus 6-segmented, with first segment longest. Mesosoma: (20) pronotum brown, imbricate-punctate with fine pilosity on dorsal and lateral surfaces; pronotal lobe with elongate, finely branched white setae; (21) mesoscutum shiny with widely scattered punctures dorsally, becoming more closely-spaced laterally; elongate, erect setae 0.20 mm long over most of the surface; notauli lacking; parapsidal lines weak; (22) mesoscutellum shiny at center becoming punctate around edges, erect setae as on mesoscutum; metanotum imbricate-punctate; (23) mesopleuron distinctly imbricate with weak punctations; erect, white setae; (24) metapleuron weakly imbricate, with fine pilosity, no long, erect setae; (25) propodeum imbricate laterally with short, fine pilosity; patch of erect setae of varying lengths on either side of entirely glabrous propodeal triangle; (26) intertegular distance 1.28–1.40 mm (\bar{x} = 1.34 \pm 0.02; n = 10); (27) forewing length 3.80–4.20 mm (\bar{x} = 3.99 \pm 0.03; n = 10); wings clear with brown wing veins and weak dark spot at apex of forewing; (28) legs brown except for white spot at base of foretibia;

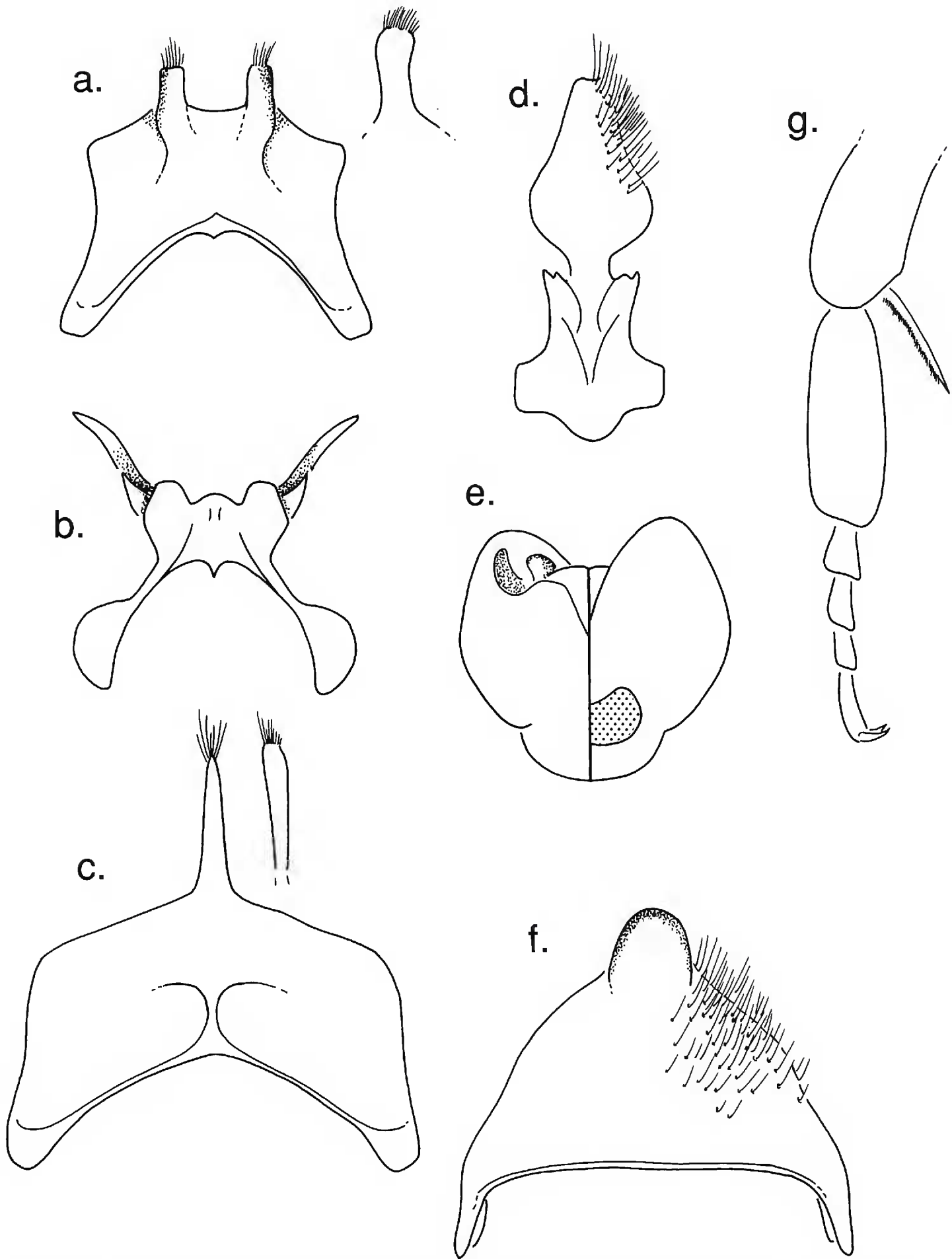


Figure 1. *Calliopsis persimilis*. Male: (a) sixth sternite, (b) seventh sternite, (c) fifth sternite, (d) eighth sternite, (e) genital capsule, (f) seventh tergite. Female: (g) midleg.

mesobasitarsus slender (length 2.5–2.9 × width; Fig. 1g); (29) basitibial plate distinctly kidney-shaped, with setae lining concave surface; (30) scopal hairs simple, erect; (31) hindtibial spurs serrate, inner longer than outer; (33) tarsal claws bifid. Metasoma: (34) terga dark brown; (35) T1 shiny, impunctate; T2–T4 minutely imbricate-punctate with small, posteriorly directed recumbent, brown setae; (36) weakly developed fovea on lateral edge of T2; (37) lateral angles of T3, T4 and all of T5 with elongate,

erect, finely-branched setae, T5 distinctly punctate; (38) pygidial plate rounded apically, surface convex and clothed in setae; (39) sterna similar in color and sculpturing to T2–T4; (40) S2 to S5 with graduli; (41) S6 like other *Calliopsis*, with medial paired laminar lobes on proximal margin between paired apodemal arms; apex simple with fringe of short setae.

Male.—Head: (42) width 1.50–1.80 mm ($\bar{x} = 1.66 \pm 0.03$; $n = 10$); (43) 1.35–1.43 ($\bar{x} = 1.39 \pm 0.01$; $n = 10$) \times broader than long; (44) clypeus granulate and distinctly punctate; (45) frons coarsely granulate with weak punctures; (46) vertex granulate to imbricate; (47) gena imbricate; (48) head black to dark brown with creamy white maculation entirely covering clypeus, subantennal plates, median supraclypeal patch and lower paraocular areas extending upward along inner margin of eyes to just above level of antennal sockets; (49) head clothed in erect, white setae; (50) inner margins of eyes converging below; eyes brown; (51) lateral ocelli separated from median ocellus by 1 ocellar diameter; (52) facial fovea slender, weakly impressed; (53) scape equal in length to flagellar segments 1–4; flagellum yellow below, with dark band above. Mouthparts: (54) labrum concolorous with frons; with central depressed glabrous area; (55) mandible yellow basally, becoming reddish apically; simple and acutely pointed; (56–60) mouthparts as in female except paraglossae slender and acutely pointed. Mesosoma: (61) pronotum imbricate dorsally and laterally with fine, short setae; pronotal lobe with erect, finely branched setae; (62) mesoscutum shiny to weakly imbricate with widely scattered, weak punctation; (63) mesoscutellum shiny, becoming distinctly punctate around lateral and posterior edges; metanotum imbricate with distinct punctation; (64) mesopleuron imbricate-punctate with erect white setae; (65) metapleuron imbricate with fine, short setae; (66) propodeum as in female; propodeal triangle glabrous with fine striations on dorsal surface; (67) intertegular distance 0.70–1.12 mm ($\bar{x} = 1.04 \pm 0.01$; $n = 25$); (68) forewing length 3.80–4.35 mm ($\bar{x} = 4.09 \pm 0.03$; $n = 25$); wings as in female except with more slender stigma and more distinct dark coloration to wing tip; (69) legs with yellow maculation on anterior surface of forefemur and all of foretibia and foretarsus, at apex of femur, and tibia and tarsus on mid and hind legs, except for dark, longitudinal spots on outer surfaces of mid and hind tibiae; (70) basitibial plate slender but distinct, with shiny concave surface; (71) mid and hindtibial spurs slender and weakly serrate; (72) tarsal claws weakly bifid. Metasoma: (73) terga brown; (74) T1–T4 imbricate-punctate with simple recumbent setae; T5–T6 with more elongate, erect, finely-branched setae; (75) fovea on lateral corners of T2 barely visible; (76) T7 with slender pygidial plate (width = 0.12–0.13 mm) well-defined by salient rim (Fig. 1f); surface colliculate; surrounding cuticle of T7 imbricate-punctate; (77) S1–S4 similar in color and sculpturing to terga; (78) S5 with elongate medial process (Fig. 1c); process length equal to width of sternite along midline; (79) S6 with distal, paired, vertically oriented, quadrate processes fringed with a comb of setae apically (Fig. 1a); (80) S7 with distal, slender, vertically oriented lamellate lobes (Fig. 1b); (81) S8 notched apically (Fig. 1d); (82) genital capsule as in Fig. 1e.

Diagnosis.—This species is very similar to *C. callops* but differs in the following respects. Male: apex of S8 notched medially (Fig. 1d); apical prong of S5 more acutely pointed and longer (Fig. 1c); apical paired projections of S6 broad and quadrate in lateral view, with a comb of apical setae (Fig. 1a); small foramen in the genital capsule (Fig. 1e); male T7, pygidial plate slender and deeply concave (Fig. 1f); male clypeus with less dense covering of hairs; yellow of clypeus typically extends above the fronto-clypeal suture along midline of face, commonly reaching level of antennal sockets. Female: pygidial plate more obtuse, surface slightly more concave; meso-basitarsus slender (length 2.5–2.9 \times width; Fig. 1g); faint black spot at apex of forewing; yellow spot absent or weakly developed on protibia and absent on mesotibia; eyes brown in pinned specimens.

Material Examined.—USA. ARIZONA. COCHISE Co.: Apache, 21.7 km SW, 27 Aug 1969, J. G. & B. L. Rozen, AMNH [0, 2]; same loc., 14 Aug 1969, J. G. & K. C. Rozen, AMNH [0, 2]; same loc., 20 Aug 1971, Rozen & Favreau, AMNH [2, 9]; same loc., 14 Aug 1974, Rozens, AMNH [0, 7]; same loc., 23 Aug 1971, Rozen & Favreau, AMNH [0, 1]; Apache, 23.3 km SW, 4 Aug 1961, J. G. Rozen, *Kallstroemia grandiflora* Torrey ex. Gray, AMNH [9, 7]; Douglas, 1.6 km E, 16 Aug 1974, Rozens & Favreau, AMNH [0, 1]; Douglas, 26.7 km N, 24 Aug 1987, J. H. Cane, KU [6, 0]; Douglas, 30 km NE, 16 Aug 1971, Rozen & Favreau, AMNH [7, 3]; Portal, 15 km NE, 18 Aug 1992, B. N. Danforth, *Physalis wrightii* Gray [11, 20]. GRAHAM Co.: Safford, 29 Jul 1954, G. D. Butler, cotton,

LACM [0, 1]. *PIMA Co.*: Sahuarita, 13 Jul 1956, R. H. Beamer, *Eurphorbia* sp., KU [0, 1]; Sahuarita, 13 Aug 1946, L. P. Wehme, LACM [0, 2]; Silver Bell Bajada, J. L. Neff, LACM [1, 31]; Tucson, San Xavier, 24 Jul 1916, share w/ Clark etc., AMNH [2, 2]. *YUMA Co.*: Yuma, 14 Oct 1936, Lauderdale, NMNH [2, 0]. CALIFORNIA. *IMPERIAL Co.*: Jun 1912, J. C. Bridwell, KU [3, 3]; Jun 1912, J. C. Bridwell, NMNH [38, 39]; May 1911, J. C. Bridwell, NMNH [13, 4]; Calexico, 14 Sep 1959, C. R. Wagner, LACM [1, 0]; Calexico, 1.6 km E, 28 Jun 1953, R. R. Snelling, *Melilotus alba* Medicus, LACM [0, 1]; Calexico, 1.6 km E, 28 Jun 1953, R. R. Snelling, *Sida hederacea* (Douglas) Torrey, LACM [1, 1]; Experimental Farm, Jun 1912, J. C. Bridwell, *Physalis*, NMNH [0, 1]. *RIVERSIDE Co.*: Indio, Keosegan Ranch, 17 Jul 1970, M. E. Irwin, cotton, UCR [1, 0]. NEW MEXICO. *HIDALGO Co.*: Animas, 1 km N, 7 Aug 1988, B. N. Danforth, *Physalis wrightii*, KU [50, 50]. MEXICO. *SINALOA*: Culiacán, 27.8 km S, 30 Sep 1976, George & Snelling, LACM [0, 5]; Los Mochis, 16 km N, 152 m, 30 Sep 1976, George & Snelling, LACM [2, 3]. *SONORA*: Guaymas, 13 km N, 1 Oct 1976, George & Snelling, LACM [1, 1]; Hermosillo, 85 km ENE, El Gavilan, 13 Aug 1991, Rozen & Pember, *Kallstroemia grandiflora*, AMNH [0, 1]; Los Alamos, 440 m, 3 Apr 1991, R. Ayala, [1, 0]. *BAJA CALIFORNIA NORTE*: Mexicali, 12 km SW, 19 Jul 1953, R. R. Snelling, *Sida hederacea*, LACM [0, 1]. *BAJA CALIFORNIA SUR*: Loreto, 48 km S, 425 m, 7 Sep 1977, R. R. Snelling, LACM [0, 1].

CALLIOPSIS (*HYPOMACROTERA*) *CALLOPS* (COCKERELL & PORTER)

Hypomacrotera callops Cockerell & Porter (1899: 419) [male, female]; Cockerell (1937:3) [holotype designation]; Rozen (1970) [biology]; Hurd & Linsley (1972) [parasite].

Types. — Holotype, male; data: NEW MEXICO. *SAN MIGUEL Co.*: Las Vegas, 1 Aug [no year], T. D. A. Cockerell, *Chamaesaracha coronopus*; deposited: American Museum of Natural History, New York.

Cockerell & Porter (1899) designated an unknown number of males and females as the original type series. Cockerell (1937:3) later designated one male from this series as the holotype

Description. — *Female.* — Head: (1) width 1.7–2.12 mm ($\bar{x} = 1.95 \pm 0.04$; $n = 10$); (2) 1.39–1.47 ($\bar{x} = 1.43 \pm 0.01$; $n = 10$) times broader than long; (3–19) as in *C. persimilis* except (7) head coloration dark brown to black with minute, creamy white spots on paraocular area immediately above mandibular acetabulum in some specimens; (9) eyes blue. Mesosoma: (20–33) as in *C. persimilis* except (20) lateral surfaces of pronotum distinctly shiny, glabrous, *not* imbricate; (26) intertegular distance 1.16–1.50 mm ($\bar{x} = 1.30 \pm 0.03$; $n = 10$); (27) forewing length 3.40–4.20 mm ($\bar{x} = 3.86 \pm 0.08$; $n = 10$); wings without dark spot at apex; (28) legs brown with white spots at base of *both* foretibia and mesotibia; mesobasitarsus broad (length 1.75–2.4 times width; Fig. 2g). Metasoma: (34–41) as in *C. persimilis* except (38) pygidial plate slightly more acute.

Male. — Head: (42) width 1.4–2.1 mm ($\bar{x} = 1.71 \pm 0.04$; $n = 10$); (43) 1.26–1.38 ($\bar{x} = 1.33 \pm 0.01$; $n = 10$) times broader than long; (44) clypeus granulate-punctate; (45) frons shiny, glabrous except for widely-scattered punctation; (46) vertex shiny with scattered punctation; (47) gena weakly imbricate, shiny; (48) head black to dark brown with white maculation as in *C. persimilis* except less extensive, barely reaching above antennal sockets and often evanescent or absent on subantennal plates and subantennal area; (49) head setae as in *C. persimilis* but setae on clypeus much more dense, mostly obscuring surface of clypeus; (50–60) as in *C. persimilis*. Mesosoma: (61–72) as in *C. persimilis* except (61) lateral surface of pronotum more shiny; (67) intertegular distance 0.75–1.10 mm ($\bar{x} = 0.99 \pm 0.02$; $n = 25$); (68) forewing length 3.20–4.65 mm ($\bar{x} = 3.98 \pm 0.06$; $n = 25$); (69) yellow on legs as in *C. persimilis* but dark spots on outer surface of mid and hind tibiae larger. Metasoma: (73–82) as in *C. persimilis* except (76) T7 with broad (width > 0.16 mm), weakly-defined, blunt pygidial plate (Fig. 2f); surface mostly shiny, weakly rugulose; (78) median process on S5 shorter (length two-thirds width of sternite along midline; Fig. 2c); apex laterally flattened, blade-like with dense apical setae (Fig. 2c); (79) apical prongs of S6 more slender in lateral view but with similar comb of setae (Fig. 2a); (80) S7 with distal lamellate lobes broad and horizontal (Fig. 2b); (81) S8 tapering to acute apex, not notched apically (Fig. 2d); (82) genital capsule as in Fig. 2e, foramen large.

Diagnosis. — This species is very similar to *C. persimilis* but is slightly larger

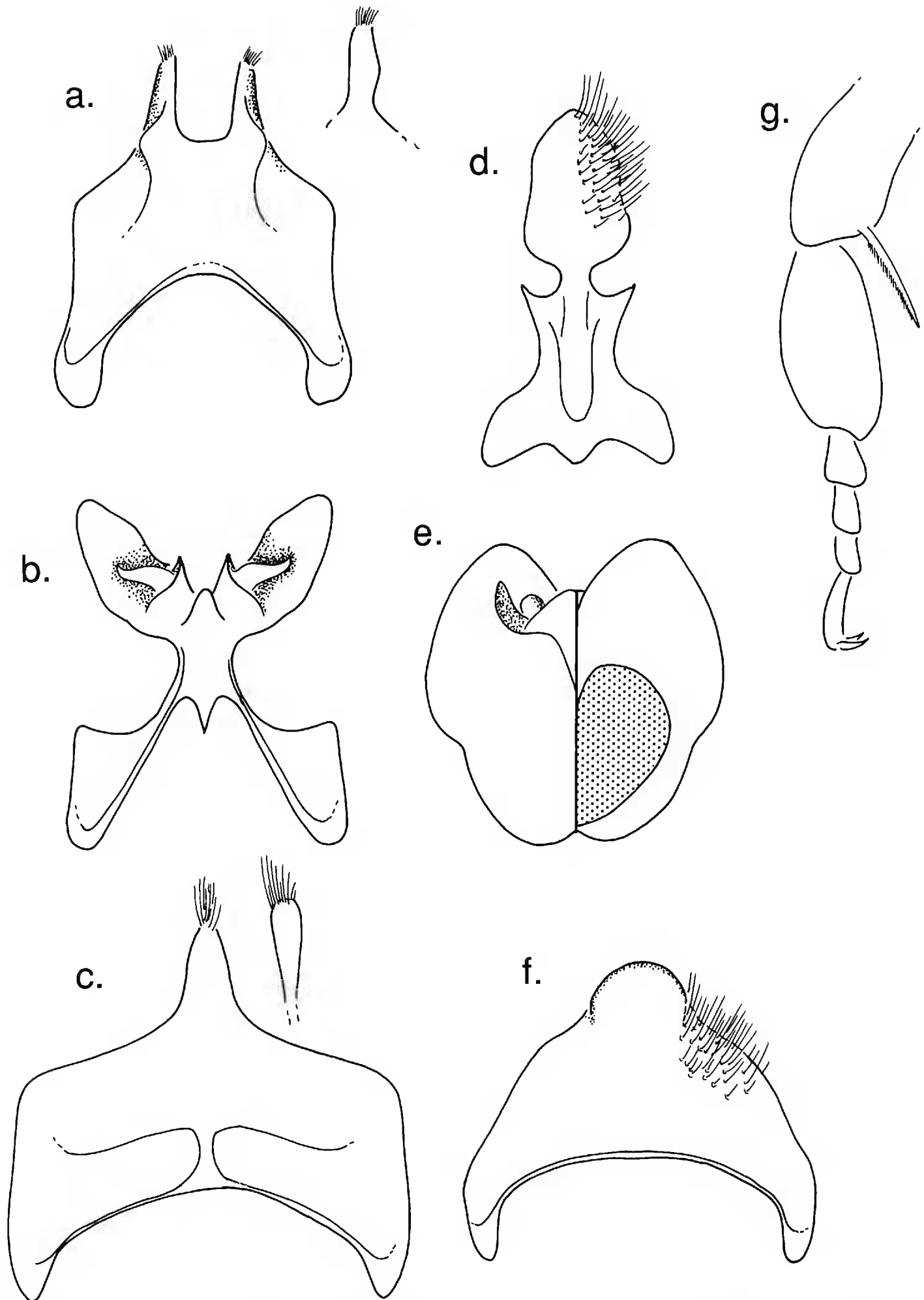


Figure 2. *Calliopsis callops*. Male: (a) sixth sternite, (b) seventh sternite, (c) fifth sternite, (d) eighth sternite, (e) genital capsule, (f) seventh tergite. Female: (g) midleg.

and differs in the following structural features: Male: apex of S8 rounded, coming to a point medially (Fig. 2d); apical prong of S5 less acutely pointed and shorter (Fig. 2c); apical paired projections of S6 acutely pointed in lateral view (Fig. 2a); large foramen in the genital capsule (Fig. 2e); male T7, pygidial plate broader and less deeply concave (Fig. 2f); male clypeus with more dense covering of hairs, which overlap the labrum; yellow of clypeus rarely extending above the fronto-clypeal suture along midline of face. Female: pygidial plate more acute; meso-basitarsus broad (length 1.75–2.4 times width; Fig. 2g); black spot at apex of wing lacking; well-developed yellow or white spot at base of pro- and mesotibiae; eyes blue in pinned specimens.

Material Examined.—USA. ARIZONA. COCHISE Co.: Douglas, 22 Aug 1968, Rozen & Favreau, AMNH [11, 7]; Douglas, 1 Sep 1968, Rozen & Favreau, AMNH [0, 1]; Douglas, 14 Aug 1969, J. G. & K. C. Rozen, AMNH [0, 1]; Douglas, 31 Aug 1968, Rozen & Favreau, AMNH [1, 0]; Douglas, 17 Aug 1970, AMNH [0, 1]; Douglas, 3 May 1969, Rozen & Favreau, AMNH [2, 2]; Douglas, 1.6 km E, 17 Aug 1971, Rozen & Favreau, AMNH [4, 0]; same loc., 21 Aug 1968, Rozen & Favreau, AMNH [2, 1]; same loc., 20 Aug 1968, Rozen & Favreau, AMNH [1, 0]; same loc., 31 Aug 1971, Rozen & Favreau, AMNH [2, 0]; same loc., 18 Aug 1971, Rozen & Favreau, AMNH [1, 0]; same loc., 29 Aug 1971, Rozen & Favreau, AMNH [4, 0]; same loc., 21 Aug 1974, J. G. & B. L. Rozen, AMNH [1, 1]; same loc., 29 Aug 1971, Rozen & Favreau, AMNH [0, 1]; same loc., 19 Aug 1968, J. G. Rozen, AMNH [2, 1]; same loc., 24 Aug 1970, J. G. Rozen, AMNH [0, 1]; Douglas, 28.3 km E, 4 Aug 1958, P. A. Opler, LACM [0, 1]; Portal, 24 Aug 1971, Rozen & Favreau, AMNH [1, 0]. COLORADO. BAVA Co.: Regnier, 1372 m, 6 Jun 1919, T. D. A. Cockerell, AMNH [0, 1]. PROWERS Co.: Lamar, 1097 m, 4 Jun 1919, T. D. A. Cockerell, AMNH [0, 1]. KANSAS. BARBER Co.: Aetna, 4.2 km S, 7 Aug 1962, Kerfoot & Michener, *Quincula lobata* (Torrey) Rafinesque, KU [10, 1]; Medicine Lodge, 25 km W, 12 May 1962, Michener & party, *Quincula lobata*, KU [1, 1]. DOUGLAS Co.: Lawrence, 24 Sep 1952, R. R. Snelling, *Helianthus petiolaris* Nuttall, LACM [0, 1]; Lawrence, 23 Aug 1952, J. A. Mathewson, *Helianthus petiolaris*, LACM [1, 0]. HAMILTON Co.: 1021 m, F. H. Snow, KU [1, 1]. STANTON Co.: Johnson, 16 Jun 1949, Michener & Beamer, *Quincula lobata*, KU [1, 1]. NEW MEXICO. EDDY Co.: Artesia, 5 km S, 20 May 1969, Brothers et al., *Chamaesaracha conioides* (Moricand) Britton, KU [1, 0]. HIDALGO Co.: Animas, 6.7 km S, 24 Aug 1974, Rozen & Favreau, AMNH [2, 4]; Cienega Ranch, 14 May 1987, J. G. Rozen, *Chamaesaracha*, AMNH [1, 0]; Rodeo, 1.6 km N, 19 Aug 1971, Rozen & Favreau, AMNH [0, 1]. SIERRA Co.: Hot Springs, 22 Jul 1950, R. H. Beamer, *Chamaesaracha conioides*, KU [4, 2]; Hot Springs, 58.3 km N, 22 Jul 1950, R. H. Beamer, *Baileya multiradiata* Harvey & Gray, KU [1, 1]. TEXAS. ARMSTRONG Co.: Claude, 36.7 km S, Palo Duro Canyon, 4 Jun 1979, C. D. Michener, *Quincula lobata*, KU [2, 0]. BREWSTER Co.: Big Bend Park, Cooper's Store, 11 Apr 1949, Michener & Beamer, *Phacelia popei* Torrey & Gray, KU [2, 0]. JEFF DAVIS Co.: Fort Davis, 33.3 km N, Davis Mts., 16 Apr 1961, Rozen & Schramel, AMNH [0, 2]. DIMMIT Co.: Carrizo Springs, 14 Apr 1949, Michener & Beamer, KU [0, 2]. HIDALGO Co.: Progreso, 12 Apr 1950, Michener et al., *Quincula lobata*, KU [5, 2]. MAVERICK Co.: Quemado, 14 Apr 1949, Michener & Beamer, *Quincula lobata*, KU [13, 5]. REEVES Co.: Toyahvale, 2.5 km S, 25 Apr 1979, R. R. Snelling, LACM [0, 1]; Toyahvale, Balmorhea State Park, 16 Apr 1961, Rozen & Schramel, AMNH [0, 1]. STARR Co.: Rio Grande (City?), 12 Apr 1950, R. H. Beamer, et al., *Quincula lobata* (1 male), KU [2, 1]. TERRELL Co.: Dryden, 21.7 km SE, 13 Apr 1949, Michener & Beamer, *Chamaesaracha conioides*, KU [0, 1]. VAL VERDE Co.: Langtry, 23.8 km NW, 549 m, 22 Apr 1973, R. R. Snelling, *Chamaesaracha sordida* (Dunal) Gray, LACM [0, 1]. MEXICO. CHIHUAHUA: Camargo, 26 km N, 27 Aug 1991, J. G. Rozen, *Quincula lobata*, AMNH [0, 1]; same loc., 27 Aug 1991, J. G. Rozen, *Euphorbia*, AMNH [1, 0]; same loc., 27 Aug 1991, J. L. Neff, *Quincula lobata*, CTMI [2, 0]; Ceballos, 49 km NE, 15 Mar 1992, D. Yanega, KU [0, 1]; Chihuahua, 38 km S, 27 Aug 1991, R. L. Minckley, *Dyssodia*, KU [2, 2]; Jiménez, 18 km NW, 26 Aug 1991, J. G. Rozen, *Dyssodia* sp., AMNH [0, 1]; same loc., 26 Aug 1991, J. G. Rozen, AMNH [1, 1]; Jiménez, 5 km E, 21 Aug 1991, J. L. Neff, *Chamaesaracha conioides*, CTMI [2, 0]; Ojinaga, 31 km W, 28 Aug 1991, R. L. Minckley, KU [0, 2]. COAHUILA: San Rafael, 1210 m, 24 Mar 1992, R. Brooks, *Chamaesaracha crenata* Rydberg, KU [2, 7]; San Rafael, 1170 m, 24 Mar 1992, J. L. Neff, *Chamaesaracha coronopus* (Dunal) Gray, CTMI [1, 0]. DURANGO: La Loma, 1249 m, 20 Aug 1947, C. D. Michener, *Physalis*, AMNH [9, 0]; Reserva Biosfera Mapimi, 23 Aug 1991, J. G. Rozen, *Chamaesaracha*, AMNH [5, 2];

same loc., 22 Aug 1991, J. G. Rozen, *Chamaesaracha crenata*, AMNH [1, 4]; same loc., 23 Aug 1991, J. G. Rozen, *Dyssodia aurea* (Gray) A. Nelson, AMNH [0, 1]; same loc., 21 Aug 1991, R. L. Minckley, *Xylothamia triantha* [sic?], KU [0, 1]; same loc., 21 Aug 1991, R. L. Minckley, *Euphorbia*, KU [0, 1]; Estacion Biológica, Mapimi, 28 Aug 1991, J. L. Neff, *Malvella leprosa* (Ortega) Krapovickas, CTMI [0, 1]; same loc., 23 Aug 1991, R. Ayala, UNAM [1, 2].

CALLIOPSIS (HYPOMACROTERA) SUBALPINUS COCKERELL

Calliopsis subalpinus Cockerell (1894:235) [male]. *Calliopsis semirufus* Cockerell (1896:219) [female].

Hypomacrotera andradensis Cockerell (1937:3) [male, female].

Hypomacrotera subalpinus, Rozen (1970) [biology].

Types.—*Calliopsis subalpinus*, Holotype, male; data: NEW MEXICO. DONA ANA Co.: Las Cruces, 1893, T. D. A. Cockerell; deposited: Academy of Natural Sciences, Philadelphia. Paratypes: same data as holotype, 1 male, 1 female; deposited: National Museum of Natural History, Smithsonian Institution, Washington, DC.

Diagnosis.—Forewing length, male: 5.0–6.4 mm; female: 5.5–6.5 mm. This species is considerably larger than *C. callops* and *C. persimilis* (roughly 1.5 to 2.0 times the size in forewing length) and differs from those two species in the following structural and coloration characters: Male: maculation on legs restricted to anterior surface of foretibia and tarsus, and a small spot at base of mesotibia; head more quadrate with yellow maculation on clypeus broken up by dark area on disk of clypeus, below fronto-clypeal suture, and yellow maculations along inner orbit of eyes slender; male T7 with elongate, well developed, concave pygidial plate (Fig. 3f); male genitalia and apical sclerites as in Figs. 3a–e; Female: T1–T4 and proximal $\frac{2}{3}$ of T5 reddish dorsally, becoming chocolate brown laterally, S1–S6 and distal $\frac{1}{3}$ of T5 deep chocolate brown; face with yellow maculation on subantennal sclerites, subantennal area immediately above fronto-clypeal suture, on lateral portions of clypeus and small spots of yellow on inner orbits of eyes just above fronto-clypeal suture; stigma elongate and slender, barely distinguishable from prestigma; marginal cell elongate and slender (length 5.0 times greatest width; length roughly 4.0 times width in *C. callops* and *persimilis*).

Synonyms.—*Calliopsis semirufus*, Holotype, female; data: NEW MEXICO. DONA ANA Co.: Las Cruces, 25 Aug 1895, *Sphaeralcea angustifolia*; deposited: National Museum of Natural History, Smithsonian Institution, Washington, DC.

Hypomacrotera andradensis, Holotype, female; data: CALIFORNIA. IMPERIAL Co.: Andrade, near Yuma, 19 Apr 1937, *Sphaeralcea*; deposited: American Museum of Natural History, New York.

Discussion.—No description of this species is given here because previous descriptions are adequate. Although Hurd (1979) recognized *andradensis* as a subspecies of *subalpinus*, I see no reason for doing so. *Calliopsis (H.) andradensis* was originally distinguished from *C. subalpinus* based on color pattern differences: in male specimens from west of the Arizona-California border the yellow maculation on the clypeus is restricted to the lateral portions, immediately beneath the eyes, but eastern specimens show yellow across the entire clypeus, and more yellow coloration overall. The width of the male pygidial plate is a correlated character. Western specimens in general show broader pygidial plates (> 0.22 mm) but eastern specimens have more slender pygidial plates (> 0.22 mm). This

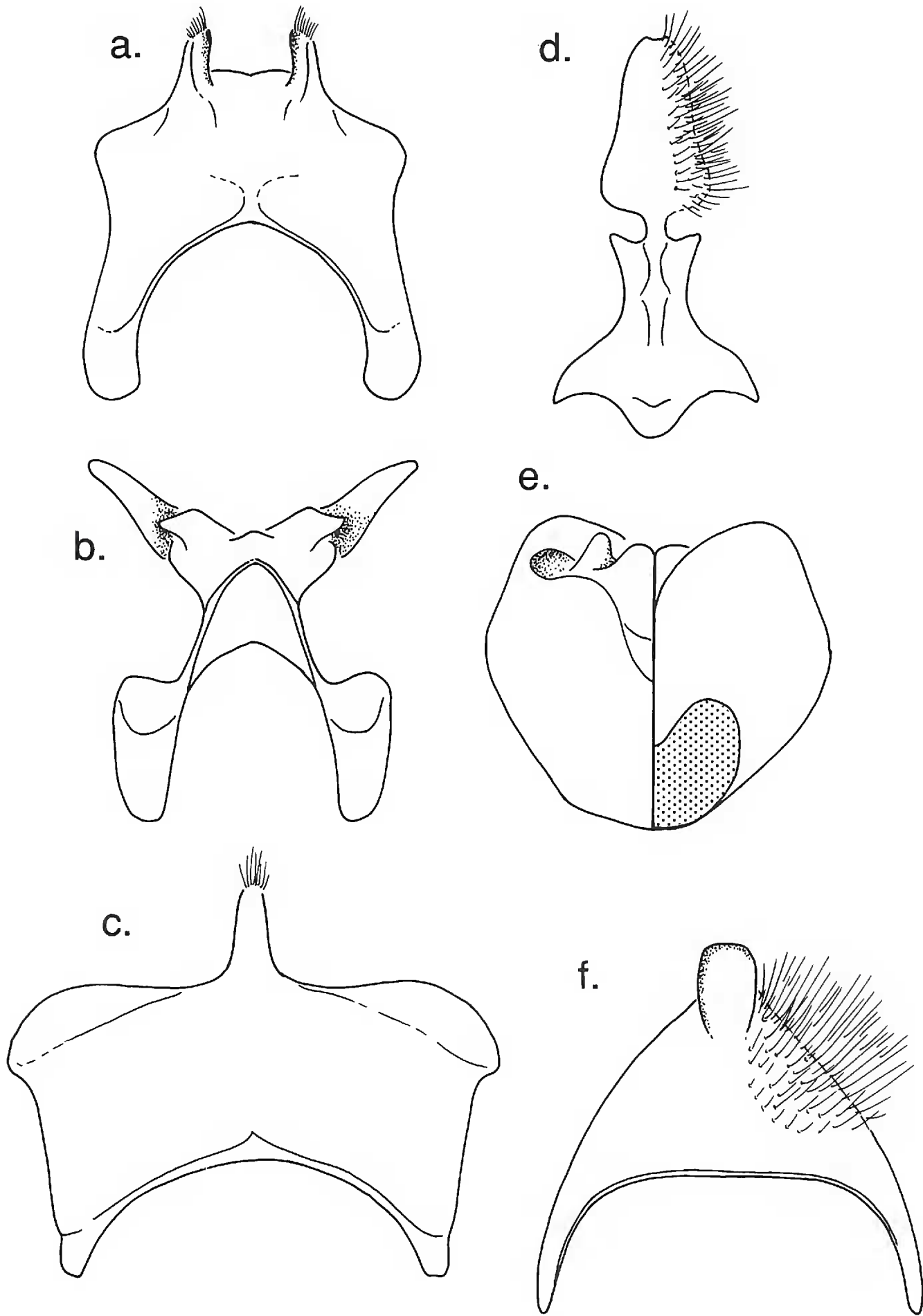


Figure 3. *Calliopsis subalpinus*. Male: (a) sixth sternite, (b) seventh sternite, (c) fifth sternite, (d) eighth sternite, (e) genital capsule, (f) seventh tergite.

character, like clypeal coloration shows a gradual transition from east to west. Neither character can be used unambiguously to separate eastern and western specimens. Therefore, I consider this insufficient basis for distinguishing two species, or even two subspecies.

Material Examined.—USA. ARIZONA. COCHISE Co.: Apache, 23.3 km SW, 7 May 1989, J. G. Rozen, AMNH [0, 1]; Apache, 3.3 km E, 17 May 1987, J. G. Rozen, AMNH [1, 0]; Bisbee, 20 km W on Hwy 92, 14 Aug 1991, B. N. Danforth, *Lepidium*, KU [2, 0]; same loc., 14 Aug 1991, B. N. Danforth, *Sphaeralcea*, KU [17, 9]; Douglas, 23 Aug 1968, Rozen & Favreau, AMNH [1, 0]; Douglas, 3 May 1969, Rozen & Favreau, AMNH [0, 5]; Douglas, 21 Aug 1968, Rozen & Favreau, AMNH [1, 2]; Douglas, 22 Aug 1968, Rozen & Favreau, AMNH [1, 0]; Douglas, 31 Aug 1968, Rozen & Favreau, AMNH [1, 0]; Douglas, 1.6 km E, 21 Aug 1968, Rozen & Favreau, AMNH [0, 1]; same loc., 19 Aug 1968, Rozen & Favreau, AMNH [0, 1] same loc., 16 Aug 1962, M. Statham, *Sphaeralcea*, AMNH [2, 1]; Douglas, 20 km NW, 30 Aug 1989, Rozen et al., AMNH [0, 1]; Portal, 16.7 km NE, 24 Aug 1966, Rozens, AMNH [2, 0]; Portal, 14 km NNE, 31 Aug 1989, B. N. Danforth, *Sphaeralcea*, KU [0, 1]; Portal, 13.3 km NE, 14 Aug 1990, Rozen & Krieger, AMNH [0, 1]; same loc., 31 Aug 1990, J. G. & B. L. Rozen, AMNH [0, 1]; same loc., 23 Aug 1989, Rozen & Foster, AMNH [0, 1]; Rodeo vicinity, 11 Jun 1987, B. N. Danforth, *Solanum*, KU [0, 1]; San Simón, 3.3–10 km S, 3 Sep 1977, J. G. Rozen, AMNH [5, 6]; San Simón, 8.3 km S, 12 May 1987, J. G. Rozen, AMNH [4, 0]; San Simón, 10 km S, 16 May 1987, J. G. Rozen, AMNH [3, 0]; same loc., 10 May 1987, J. G. Rozen, *Sphaeralcea*, AMNH [1, 0]. LA PAZ Co.: Salome, 30 Aug 1979, E. M. Fisher, LACM [0, 1] MARICOPA Co.: Gila Bend, 26 Mar 1940, R. H. Crandall, LACM [1, 0]; Gila Bend, 28.3 km S, 14 Apr 1968, E. M. Fisher, LACM [1, 1]; Sentinel, 25 Mar 1960, Gertsch & Schramel, AMNH [0, 9]; Tonopah, 8.3 km E, 24 Apr 1961, Rozen & Schramel, AMNH [0, 3]. MOHAVE Co.: Kingman, 50 km W, 13 May 1980, Rozens, AMNH [0, 2]; Nixon Springs, 60 km NW, 5 Aug 1969, R. R. Snelling, *Sphaeralcea*, LACM [0, 1]. PIMA Co.: Tucson, 10 Jun 1938, R. H. Crandall, LACM [2, 1]. PINAL Co.: Sacaton, (no date), T. H. Kearney, *Sphaeralcea*, NMNH [1, 0]. YAVAPAI Co.: Chino Valley, 6.7 km N, 31 Jul 1961, J. G. Rozen, AMNH [0, 1]; Congress, 33.3 km NW, 29 Apr 1991, J. G. Rozen, AMNH [1, 0]; Morristown, 35 km E, 24 Apr 1991, J. G. Rozen, AMNH [1, 0]. YUMA Co.: Dome Valley, 3 May 1991, J. G. Rozen, *Sphaeralcea*, AMNH [5, 2]; Ligurta, 20 Apr 1973, Rozen, AMNH [0, 2]; (no specific locality data), Ashmead, NMNH [0, 1]. CALIFORNIA. IMPERIAL Co.: May 1911, J. C. Bridwell, *Sphaeralcea orcuttii* Rose, NMNH [34, 2]; Apr 1911, J. C. Bridwell, NMNH [5, 7]; Andrade, 21 Jun 1953, R. R. Snelling, *Sphaeralcea orcuttii*, LACM [0, 2]; Calexico, 1.6 km E, 28 Jun 1953, R. R. Snelling, *Sphaeralcea orcuttii*, LACM [1, 0]; Calexico, 20 km E, 20 Apr 1949, R. C. Dickson, *Sphaeralcea orcuttii*, LACM [0, 1]; Experimental Farm, 21 May 1912, J. C. Bridwell, *Sphaeralcea orcuttii*, NMNH [0, 1]; Experimental Farm, Jun 1912, J. C. Bridwell, NMNH [0, 1]; Glamis, 28.7 km NW, 3 May 1958, E. L. Sleeper, LACM [2, 0]; Imperial, 29 Apr 1950, C. D. MacNeil, AMNH [0, 1]; Imperial, 16.7 km W, 26 Apr 1951, C. D. MacNeil, AMNH [2, 0]; Imperial, 8.3 km NW, 27 Apr 1951, C. D. MacNeil, AMNH [2, 7]. INYO Co.: Eureka Valley Dunes, 4 May 1977, J. C. Hall, *Sphaeralcea*, LACM [0, 1]. RIVERSIDE Co.: Blythe, 30 km W, 8 Apr 1979, E. M. Fisher, *Sphaeralcea*, LACM [2, 0]; same loc., 8 Apr 1979, E. M. Fisher, *Baileya*, LACM [0, 11]; same loc., 17 Apr 1973, Rozens, AMNH [1, 1]; same loc., 17 Apr 1973, Rozens, *Sphaeralcea*, AMNH [2, 17]; same loc., 17 Apr 1973, Rozens, *Malacothrix*, AMNH [0, 1]; Blythe, 30–33 km W, 29 Mar 1958, Menke & Stange, LACM [1, 0]; Desert Center, 45 km E, 25 Apr 1961, Rozen & Schramel, AMNH [2, 1]; Joshua Tree National Monument, 14 Jun 1965, Sleeper & Jenkins, LACM [1, 0]. SAN BERNARDINO Co.: Adelanto, 6.7 km NW, 884 m, 18 Sep 1978, R. R. Snelling, *Sphaeralcea ambigua* Gray, LACM [7, 2]. NEW MEXICO. BERNALILLO Co.: Albuquerque, 1524 m, 28 May 1944, W. O. Griesel, *Oryzopsis*, LACM [0, 1]. DONA ANA Co.: Mesilla, 1 Jul 1923, Cockerell, *Sphaeralcea angustifolia* (Cavanilles) G. Don, NMNH [1, 0]. HIDALGO Co.: Animas, 1 km N, 1 Aug 1988, B. N. Danforth, *Sphaeralcea*, KU [7, 3]; Animas, 33.3 km S, 12 Sep 1977, Rozens, AMNH [1, 0]; same loc., 14 Sep 1977, B. L. Rozen, AMNH [1, 0]; same loc., 13 Sep 1977, Rozens, AMNH [2, 2]; Animas, 35 km S, 25 Aug 1975, Rozens, AMNH [3, 2]; same loc., 21 Aug 1975, Rozens, AMNH [0, 1]; same loc., 18 Aug 1975, Rozens, AMNH [1, 0]; Animas, 38.3 km S, 28 Aug 1975, Rozen & McGinley, AMNH [1, 0]; Animas, 41.6 km S, 30 Aug 1975, Rozens, AMNH [1, 0]; Animas, 6.7 km S, 24 Aug 1974, Rozen & Favreau, AMNH [1, 1]; Cienega Ranch, 16 Aug 1974, Rozen & Favreau, AMNH [2, 0]; Cotton City, 6.7 km NW, 22 Aug 1983, Rozen & Favreau, AMNH [2, 1]; Rodeo, 24 Jun 1987, B. N. Danforth, *Sphaeralcea*, KU [1, 0]; Rodeo, 20 km N, 15 Aug 1976, J. G. Rozen, AMNH [0, 1]; Rodeo, 21.7 km N, 19 May 1987, J. G. Rozen, AMNH [1, 0]; Rodeo, 2.5 km N, 12 Aug 1991, B. N. Danforth, *Sphaeralcea*, KU [1, 0]; Rodeo, 7.5 km N, 21 Sep 1962, J. G. Rozen et al., AMNH [1, 0]. LINCOLN Co.: Carrizozo, S on Rte 54, 15 May 1987, B. N. Danforth, *Sphaeralcea* sp., KU [8, 0]. VALENCIA Co.: Pueblo Laguna, 23 Jun 1959, Snelling & Snelling, *Sphaeralcea ambigua*, LACM [1, 1]. NEVADA. WASHOE Co.: Patrick, 16 May 1964, A. Gillogly, LACM [1, 2]. TEXAS. BREWSTER Co.: Big Bend National Park, Rio Grande Village, 18 Apr 1970, L. B. & C. W. O'Brien, LACM [0, 3]. CULBERSON Co.:

Van Horn, 12.7 km S, 27 Apr 1979, R. R. Snelling, LACM [1, 2]. *HUDSPETH Co.*: Dell City, 3.3 km N, 31 Jul 1950, R. F. Smith, AMNH [4, 0]. *PECOS Co.*: Imperial, 17 Apr 1961, Rozen & Schramel, AMNH [1, 0]. *REEVES Co.*: Balmorhea, 16 Apr 1961, Rozen & Schramel, AMNH [2, 3]; Pecos, 53.3 km ESE, 17 Apr 1961, Rozen & Schramel, AMNH [1, 0]; Toyahvale, 2.5 km S, 25 Apr 1979, R. R. Snelling, LACM [4, 3]. *TERRELL Co.*: Dryden, 17.8 km S, 670 m, 22 Apr 1973, R. R. Snelling, LACM [9, 0]. *UVALDE Co.*: Uvalde, Nueces River, 11 Jul 1941, J. J. duBois, LACM [2, 0]. *WARD Co.*: Monahans, 10 km S, 17 Apr 1961, Rozen & Schramel, AMNH [0, 1]. *ZAPATA Co.*: San Ygnacio, 15 Apr 1952, Michener et al., *Lindheimera texana*, LACM [0, 1]. MEXICO. *CHIHUAUA*: Salaces, 1584 m, 20 Aug 1947, G. M. Brandt, AMNH [0, 1]; Samalayuca, 17 km S, 31 Aug 1992, B. N. Danforth, *Sphaeralcea incana* Torrey, KU [2, 2]. *COAHUILA*: General Cepeda, 3 km W, 1550 m, 23 Mar 1992, D. Yanega, *Sphaeralcea angustifolia*, KU [0, 1]; Guadalupe, 23 Aug 1947, M. Cazier, AMNH [2, 0]; San Lorenzo, 2 km N, 1430 m, 24 Mar 1992, B. Alexander, *Thelocactus bicolor* (Galeotti) Britton & Rose, KU [0, 1]. *DURANGO*: La Loma, 1250 m, 20 Aug 1947, C. D. Michener, AMNH [9, 2]; Mapimi, 12 km E, 1350 m, 25 Mar 1992, R. Brooks, *Sphaeralcea angustifolia*, KU [0, 1]. *SONORA*: Pueblo el Molinote, 21 Apr 1990, B. N. Danforth, *Sphaeralcea*, KU [0, 2]; San José de Guaymas, 10 Apr 1900, L. O. Howard, NMNH [1, 0]. *ZACATECAS*: Concepcion del Oro, 10 Aug 1981, J. L. Neff, *Sphaeralcea*, LACM [1, 3].

DISCUSSION

Phenology.—Figure 4a shows the collection data expressed as number of specimens collected per month from February through November. *Calliopsis callops* and *C. subalpinus* show clearly bimodal patterns corresponding to the bimodal rainfall typical of the Sonoran and Chihuahuan deserts (Sellers & Hill 1974). *Calliopsis persimilis*, however, shows a large peak in June, typically a very dry month. This peak results from a single collection of 83 specimens made by J. C. Bridwell in Imperial County, California in 1912.

The spring records of *C. callops* were primarily collected in the eastern part of the range, in Texas and Coahuila, but the late summer specimens were collected further west, in Arizona, Chihuahua and Durango, where late summer “monsoon” rainfalls are common.

Floral Associations.—There can be little doubt that *H. subalpinus* females restrict their pollen foraging to species of *Sphaeralcea* (Malvaceae) (Fig. 4b). Species visited include *S. ambigua* Gray, *S. angustifolia*, *S. incana* and *S. orcuttii*.

The other two species of *Hypomacrotera* appear to restrict their pollen-collecting to members of solanaceous genera: 89.6% of *C. callops* females and 75.6% of *C. persimilis* females were collected on solanaceous genera including *Physalis*, *Quincula* and *Chamaesaracha*. These three genera, along with five others, belong to the “physaloid genera” (Averett 1979), a group of low-growing, desert plants with non-poricidal anthers. While the single species of *Quincula*, *Q. lobata*, has been placed in *Physalis* by various sources (Correll & Johnston 1970, Kearney & Peebles 1960, Martin & Hutchins 1981), *Quincula* continues to be recognized as a distinct genus closely related to either *Chamaesaracha* or *Physalis* (Averett 1979; M. Nee, personal communication).

Calliopsis persimilis and *C. callops* also show slight differences in plant preference (Fig. 4b). Although *C. persimilis* shows a clear preference for species of *Physalis*, in particular *P. acutifolia* (Miers) Sandwith (= *P. wrightii*), female *C. callops* are more commonly collected on *Chamaesaracha* (*C. conioides*, *C. crenata*, and *C. sordida*) and *Quincula lobata* than on *Physalis*.

Field studies support these results. Danforth (1990) found *C. persimilis* collecting pollen exclusively from *Physalis acutifolia* (as *P. wrightii*) near Animas, New Mexico, and Rozen (1970) found *C. subalpinus* visiting *Sphaeralcea* sp. near

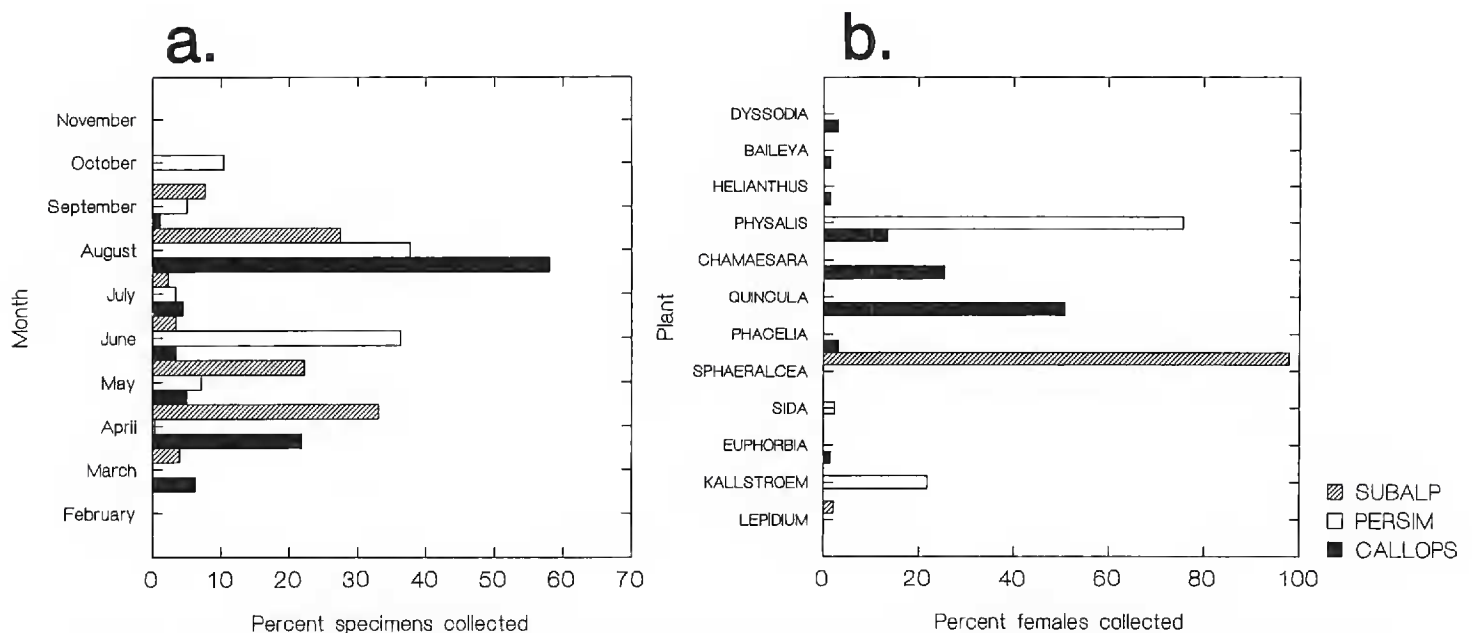


Figure 4. (a) Collection data expressed as percent of all specimens collected per month. (b) Host plant association records expressed as percent of female specimens with associated plant data collected on each of 12 plant genera. Plant genera arranged in order of families given in USDA National List of Scientific Plant Names. (CHAMAESARA = *Chamaesaracha*, KALLSTROEM = *Kallstroemia*.)

Douglas, Arizona. Rozen's (1970) report of *C. callops* (as *Hypomacrotera callops callops*) visiting *Physalis* sp. near Douglas, Arizona is in error. The bees were collecting pollen and nectar from a species of *Chamaesaracha* that still grows abundantly at the site (J. Rozen, personal communication). If one included all the female *C. callops* collected by Rozen and colleagues at the Douglas locality ($n = 31$) in the histogram of plant preferences (Fig. 4b), the preference of *C. callops* for *Chamaesaracha* over *Physalis* would be even more apparent.

Calliopsis callops and *C. persimilis* are clearly more closely related to each other than either is to *C. subalpinus*, and the plant data support that hypothesis. The species pair of *callops* + *persimilis* are solanaceous specialists, whereas *C. subalpinus* is an unambiguous oligolectic on *Sphaeralcea*. Oligolecty, or restricted pollen foraging, is widespread among panurgine bees. Examples include *Arhyso-sage* species foraging exclusively on *Opuntia* (Cactaceae) (Jørgensen 1909), *Cal-lonychium petuniae* Cure & Wittman on *Petunia* (Solanaceae) (Cure & Wittmann 1990), and *Perdita* species specializing on particular genera in over 30 plant families (Danforth 1991). Within *Calliopsis* sensu lato (Ruz 1991), there is considerable variation in the degree of specialization and in the plant groups visited. The subgenus *Calliopsis* includes species that are fairly polylectic, such as *C. (C.) andreniformis*, which collects pollen from 12 different plant families (Shinn 1967). The remaining subgenera of *Calliopsis* typically show much more oligolectic habits: most *C. (Perisander)* species are oligolectic on *Euphorbia*, *C. (Calliopsima)* species typically collect composite pollen, and the *Calliopsis* subgenera *Nomadopsis*, *Macronomadopsis* and *Micronomadopsis* are almost all oligolectic, specializing on one or two genera within various plant families including Leguminosae, Liliaceae, Hydrophyllaceae, Euphorbiaceae, Rosaceae and Boraginaceae (Rozen 1958).

Because of this diversity in host plant usage among closely-related *Calliopsis* species, it is impossible to polarize host-plant association in the subgenus *Hypomacrotera*. Based on outgroup comparison, one cannot say whether the host plant shift has gone from *Sphaeralcea* to Solanaceae, vice versa, or whether the

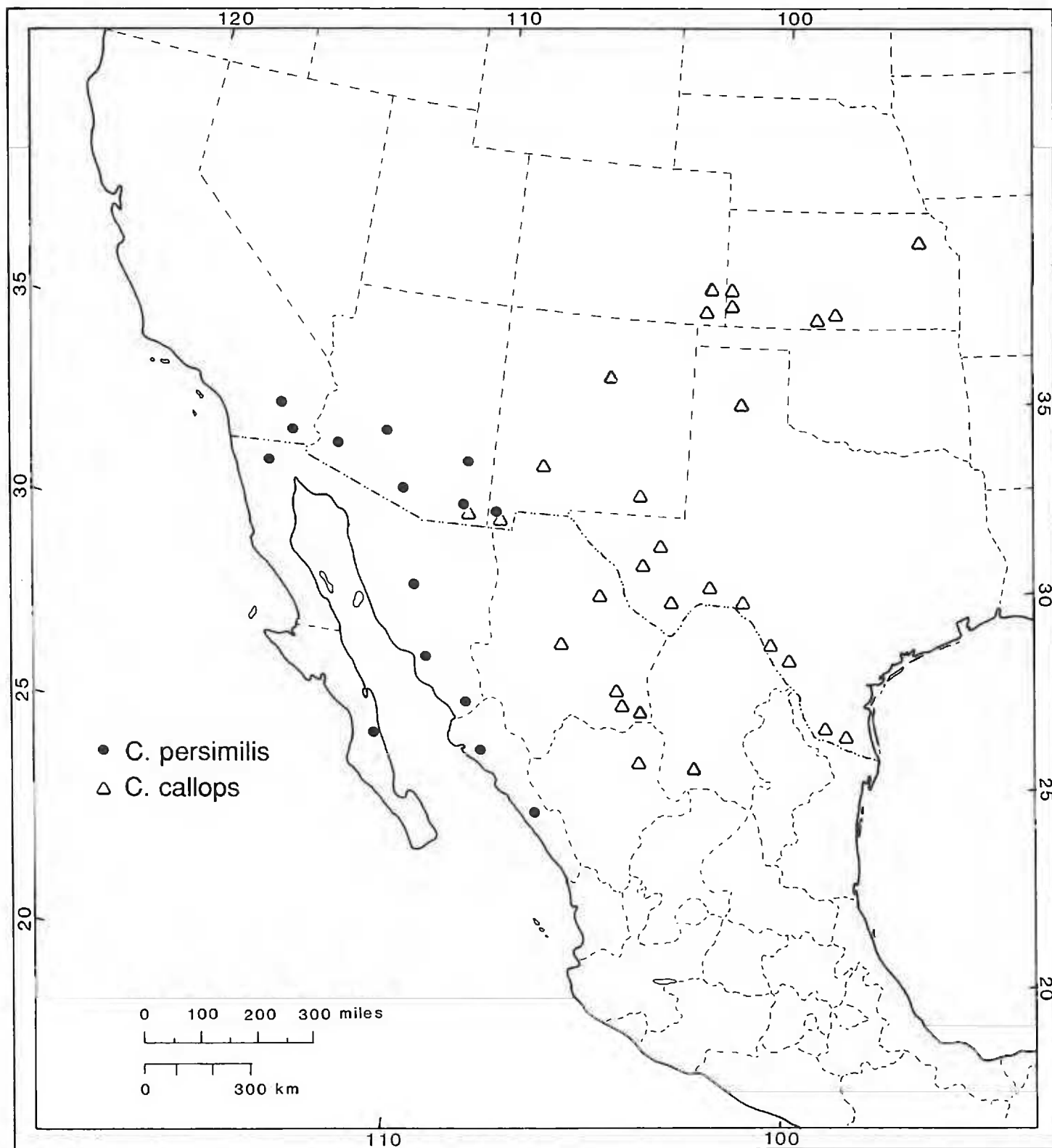


Figure 5. Geographical distribution of *C. callops* and *C. persimilis*.

common ancestor of these three species had a completely different source of pollen. The most interesting *Calliopsis* subgenus in this regard is *Liopoeum* because it is the sister group to *Hypomacrotera* (Ruz 1991). However, little is known of the host plants used by this group of South American bees.

Geographical Distribution.—*Calliopsis subalpinus* (Fig. 6) is widespread throughout the Sonoran and Chihuahuan deserts of southern California, Arizona, New Mexico, western Texas and northern Mexico. The distribution patterns of the sister species *C. callops* and *C. persimilis* show a biogeographic pattern congruent with the division of the arid southwestern U.S. and northern Mexico into lowland, western, Sonoran desert and the upland, easterly, Chihuahuan desert (Shreve 1942) (Fig. 5). The distribution of *C. persimilis* corresponds closely to the distribution of Sonoran desert (Shreve & Wiggins 1964). *Calliopsis callops*

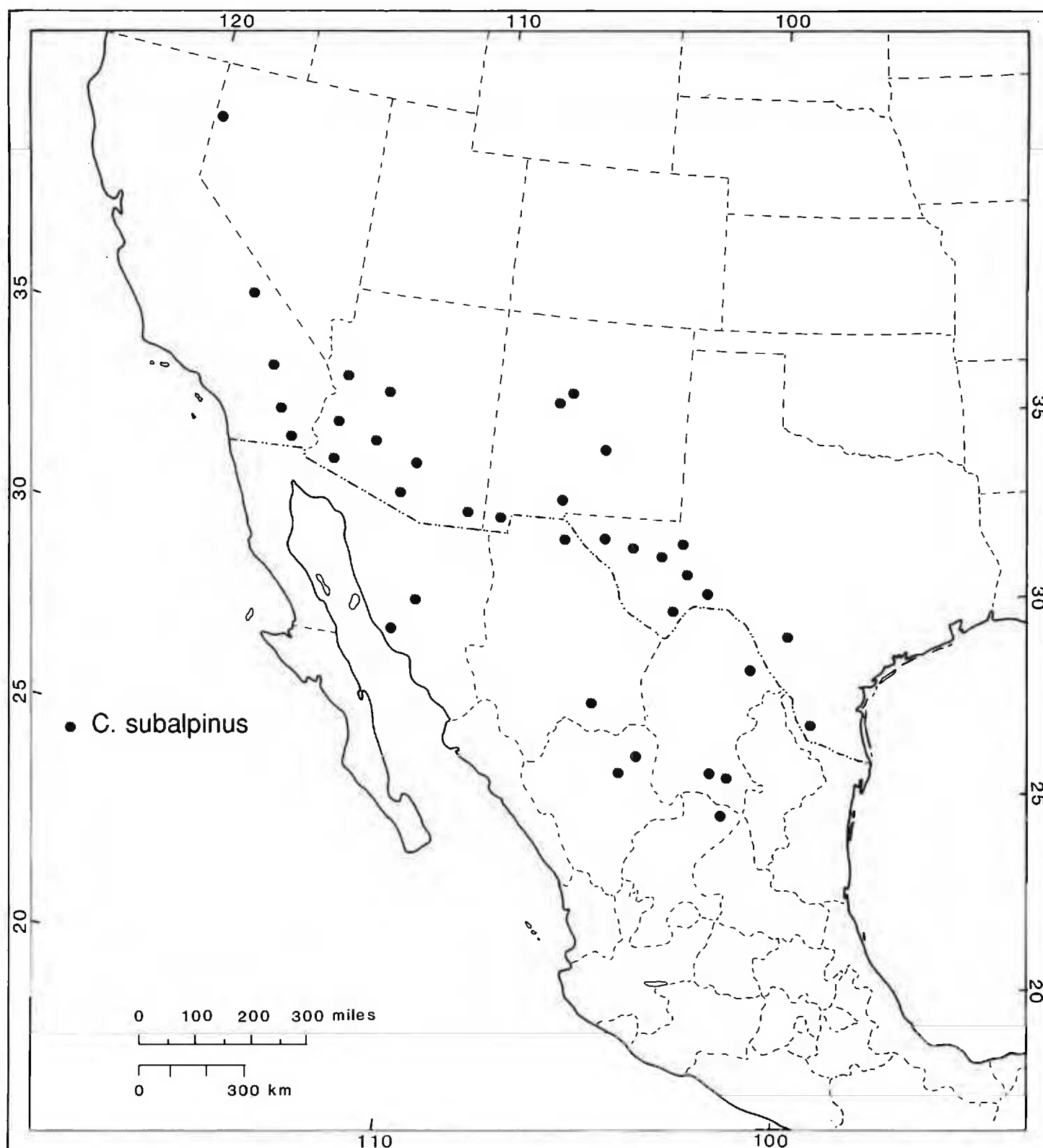


Figure 6. Geographical distribution of *C. subalpinus*.

shows a roughly Chihuahuan desert distribution in the southern portions of its range but extends northward into grassland regions of northern New Mexico, west-central Texas, Colorado, southwestern Kansas and (presumably) western Oklahoma. Although the lowland areas of southeastern Arizona to southwestern Texas, Chihuahua, Durango, and Coahuila are classified as Chihuahuan desert, in fact, these areas are a patchwork of true Chihuahuan desert and semi-desert grassland (Brown 1982, Brown & Lowe 1980). *Calliopsis callops* most likely inhabits these desert-grassland habitats in the southern parts of its range, which easily accounts for its extension into true grassland further north. The record of *C. callops* in northeastern Kansas (one male and one female collected near Lawrence, Douglas Co.), however, is almost certainly due to an error in labeling

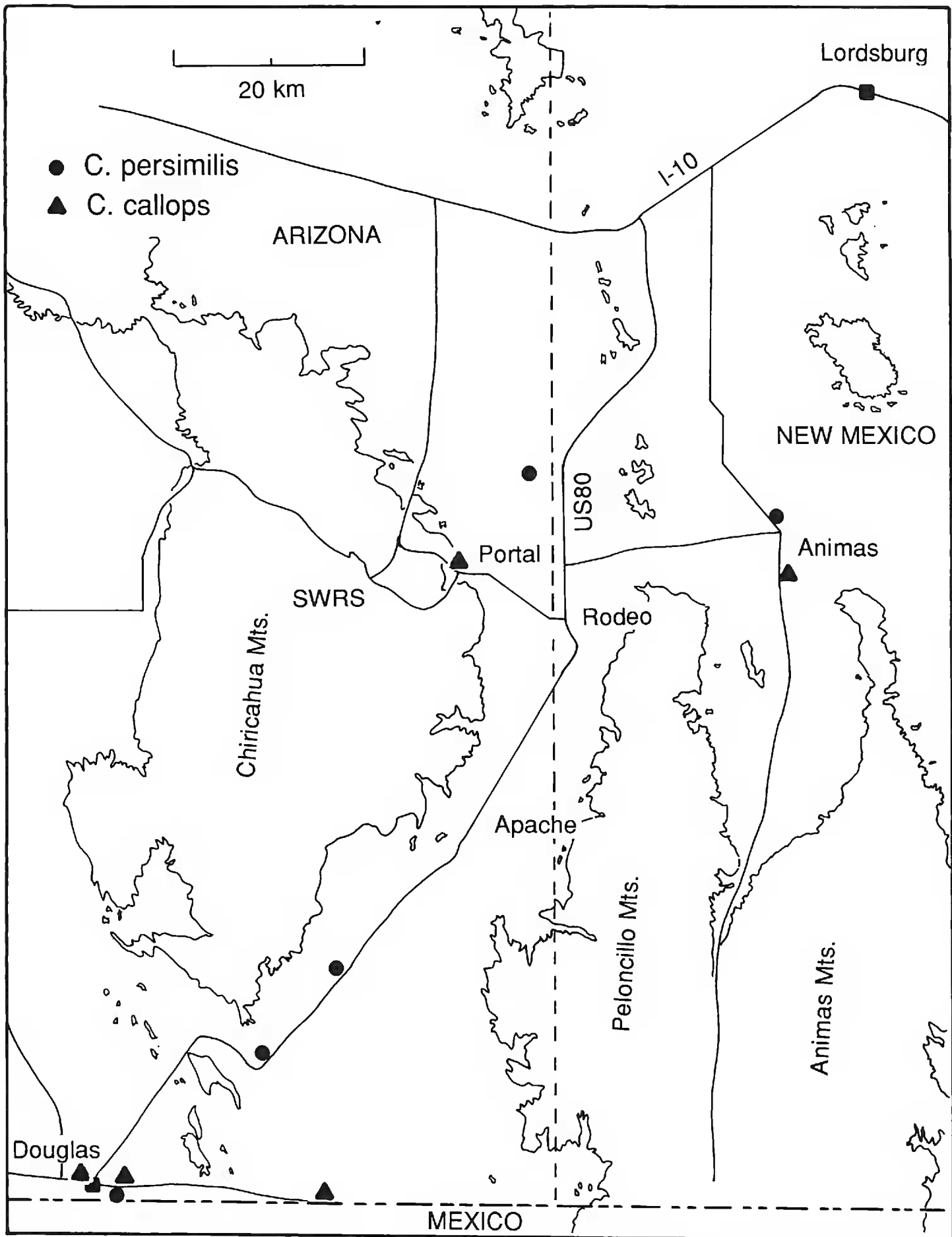


Figure 7. Distributions of collecting sites in Cochise County, Arizona and Hidalgo County New Mexico showing region of range overlap for *C. persimilis* and *C. callops*.

because the northern-most range of *Quincula* is 200 miles to the southwest of this locality.

Figure 7 shows the area where the ranges of *C. callops* and *C. persimilis* overlap in southern Arizona and New Mexico. Although specimens of *C. callops* have,

in general, been collected eastward, and *C. persimilis* westward, there is a region of overlap roughly 25 miles (42 km) wide that runs parallel to the San Simón Valley, just west of the Arizona-New Mexico border. Within this overlap zone specimens of the two species are easily distinguishable, which supports the view that they are, in fact, good species. Plants, in particular *Larrea divaricata* Cavailles (Wells & Huntziker 1976; Yang 1961, 1970; Yang & Lowe 1968), show similar patterns of vicariance in this area.

The distributions of *C. callops* and *C. persimilis* are correlated with the distributions of the plant genera that serve as their pollen sources. In order to assess this relationship, I compiled lists of the plant species that could potentially serve as pollen sources by consulting regional floras (Correll & Johnston 1970, Kearney & Peebles 1960, Martin & Hutchins 1981, Munz & Keck 1968) and then accepting synonymy decisions in the USDA National List of Scientific Plant Names (1982). The genera that primarily serve as pollen sources for *C. callops* (*Chamaesaracha* and *Quincula*) reach the western-most limits of their ranges in eastern Arizona. In contrast, nine of the seventeen species of *Physalis* occurring in the southwestern U.S. extend westward into southern California and thereby overlap all or a part of the range of *C. persimilis*. In other words, neither *Quincula lobata* nor the seven southwestern species of *Chamaesaracha* combined could serve as a pollen source for *C. persimilis* over its entire range.

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